

Site Visit Report to United Water System in Arnaudville, LA

August 24, 2010

During the week of July 26, 2010, a Battelle team made a site visit to the United Water System in Arnaudville, LA. The tasks accomplished during this site visit are as follows:

- Measured freeboard in both pressure filtration tanks to determine the volume of media after a media replenishment in May 2010; media samples also were collected
- Inspected current PLC settings and made necessary changes if warranted
- Measured water quality parameters at the AC location to confirm that no oxygen was introduced to the influent to the filtration tanks
- Observed filter backwash to determine the cause of reported frequent alarms during backwash
- Adjusted potassium permanganate (KMnO₄) feed concentration and chemical feed pump flowrates to ensure proper KMnO₄ dose
- Conducted a filter run-length study under the modified conditions

Freeboard measurements

Upon arrival, the freeboard of each pressure filtration tank was measured. Previously, because of frequent backwashing at elevated flowrates, Macrolite[®] media had been lost from the pressure filtration tanks. Freeboard measurements taken in late February 2010 were 47.75 and 47.50 in for Tanks A and B, respectively. Given the dimensions of the tanks, these freeboards correspond to an approximate media volume of 52 ft³ per tank. The design volume for each tank is 76 ft³, indicating a loss of approximately 24 ft³ of media per tank. About 24 ft³ of media was placed in each tank in May 2010. Freeboard measurements taken upon arrival were 39.25 and 38 in for Tanks A and B, respectively. These measurements correspond to a media volume of 78 ft³ for Tank A and 83 ft³ for Tank B. Table 1 summarizes the results of freeboard measurements before and after media replenishment in May 2010.

A media sample also was taken and observed to have a significant amount of particulate iron on the media. The media, however, was not cementitious.

Table 1. Previous and Current Freeboard Measurements and Media Volumes

Tank	Freeboard Measured in Late February 2010 (in)	Media Volume Before Media Replenishment (ft ³)	Freeboard Measured upon Arrival (in)	Media Volume After Media Replenishment (ft ³)
A	47.50	52	39.25	78
B	47.75	52	38.00	83

PLC Settings

Table 2 recorded PLC settings upon arrival and during the run-length study.

Table 2. PLC Settings

Parameter	Unit	Upon Arrival	During Run-length Study
Δp Trigger	psi	10	20 ^(a)
Δp Trigger Delay	sec	99	99
Service Time Trigger	hr	24	24
Standby Time Trigger	hr	48	48
BW Drain Time	min	6	4
Air Sparge Time	min	5	5
Settle Time	min	1	4
Minimum BW Time	hr	12	5
Maximum BW Time	hr	12	20
BW Turbidity Threshold	NTU	20	20
Low BW Setpoint	gpm	200	200
Minimum Effluent Setpoint	gpm	200	0
Filter-to-waste Time	min	2	2

(a) Δp Trigger reset to 6 psi upon completion of run-length study due to early iron breakthrough.

Water Quality Parameters

Dissolved oxygen (DO) and oxidation-reduction potential (ORP) were measured at the wellheads (IN) and after chlorination (AC) and the results are summarized in Table 3. ORP values as low as -71.4 mV were measured at the wellheads, indicating that groundwater from both wells was reducing. In concert with this were the low DO values (0.20 and 0.21 mg/L), which were also measured at the wellheads. DO values at the AC location were similar with or without KMnO₄ addition (0.10 vs. 0.11 mg/L). The ORP reading increased from -20.3 to 231.4 mV with a KMnO₄ residual of 0.2 mg/L in the water. The low DO and ORP values measured indicate that no oxygen had entered the system before the AC sampling location.

Table 3. Water Quality Parameters at IN and AC Locations

Location	Date @ Time	Conditions	DO (mg/L)	ORP (mV)	KMnO ₄ (mg/L) ^(a)
Well 1	7/27/10 @ 0830	-	0.21	-53.2	NA
Well 2	7/27/10 @ 0845	-	0.20	-71.4	NA
AC	7/27/10 @ 0900	W/KMnO ₄	0.10	231.4	0.20
AC	7/27/10 @ 0915	WO/ KMnO ₄	0.11	-20.3	0.00

Filter Backwash

Both filters were backwashed and records of duration and turbidity during each step of the backwash cycle were kept. Table 4 summarizes the expected (from the PLC settings) and actual duration of each backwash step for Tanks A and B.

Table 4. PLC Settings and Recorded Values During Backwash

PLC Setting	Value	Tank A Recorded Value	Tank B Recorded Value
Drain Time (min)	4.00	1.75	2.75
Air Sparge Time (min)	5.00	1.75	2.00
Settle Time (min)	4.00	4.33	4.33
Min. Backwash Time (min)	5.00	9.50	9.75
Max. Backwash Time (min)	20.00		

Several observations were made during filter backwash:

- Actual values for drain time, air sparge time, settle time and backwash time were different from the values set in the PLC.
- The values recorded for both tanks were different from one another.
- The end of backwash was triggered by the maximum backwash time alarm. Normally, this alarm would be set off only when a backwash has reached maximum backwash time and the turbidity of the backwash wastewater is still higher than the NTU setting of, in this case, 20 NTU.
- The inline turbidimeter did not function properly and produced false readings (e.g., low readings for water with high turbidity but high readings for relatively clear water)

KMnO₄ Addition

The KMnO₄ feed solution was targeted to 20,000 mg/L which, given the system flowrate, would require a chemical feed pump flowrate of approximately 150 mL/min to ensure a dose of 1.5 mg/L. Fifty gal of a feed solution was mixed in both chemical day tanks and its concentration was measured using the free chlorine method on a Hach colorimeter after proper dilutions. The concentration of the feed solution was measured at approximately 19,500 mg/L. The chemical feed pumps were then calibrated to allow for proper KMnO₄ dosing.

Run-length Study

The run-length study was conducted to determine the time to reach arsenic and iron breakthrough between two consecutive backwash cycles. Figures 1 to 4 track the arsenic and iron concentrations (in µg/L) at the AC and TA sampling locations. Table 5 presents the full data set. Iron and KMnO₄ concentrations were tracked onsite using a Hach colorimeter; however, the iron values presented in Figure 2 were obtained from ICP-MS analysis. No attempt was made to measure arsenic or manganese concentration onsite.

KMnO₄ concentrations measured at the AC location ranged from 0.26 and 0.80 mg/L (as KMnO₄); KMnO₄ concentrations measured at the TA location ranged from 0.01 and 0.17 mg/L (as KMnO₄). The

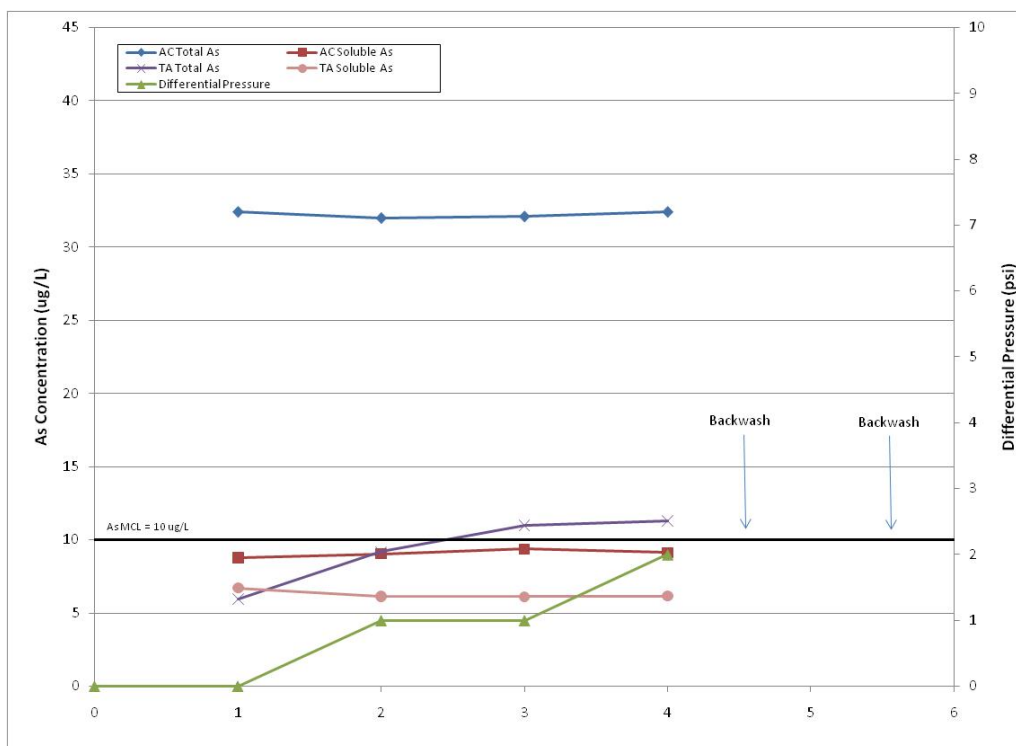


Figure 1. Total and Soluble Arsenic Concentrations During Initial Run-length Study

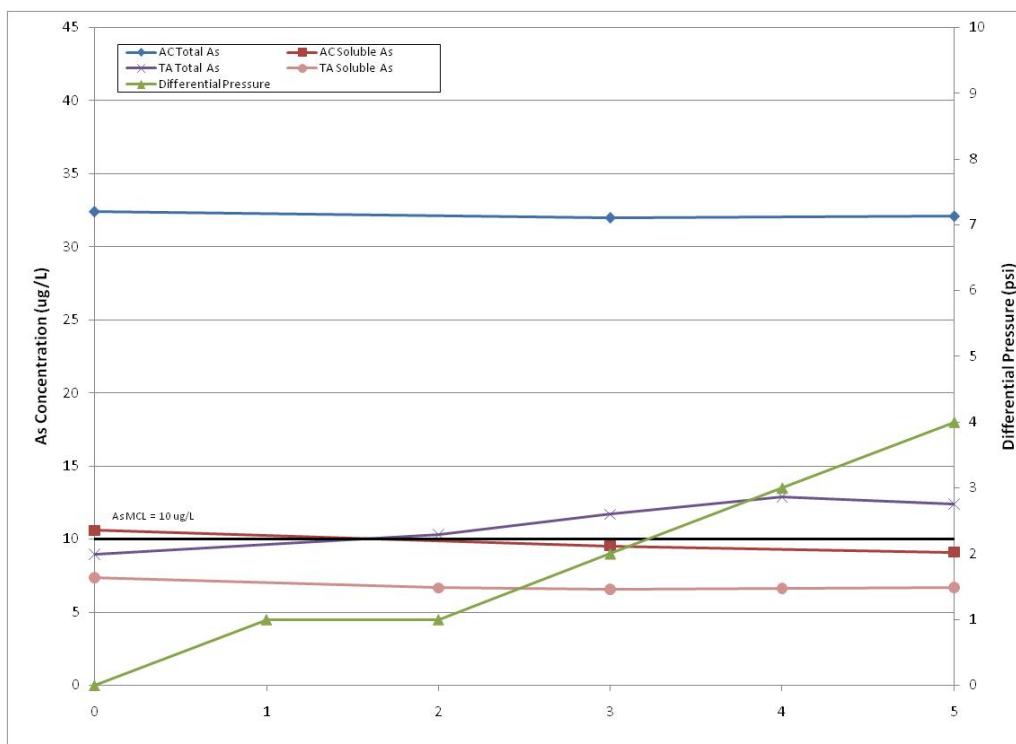


Figure 2. Total and Soluble Arsenic Concentrations During Resumed Run-Length Study

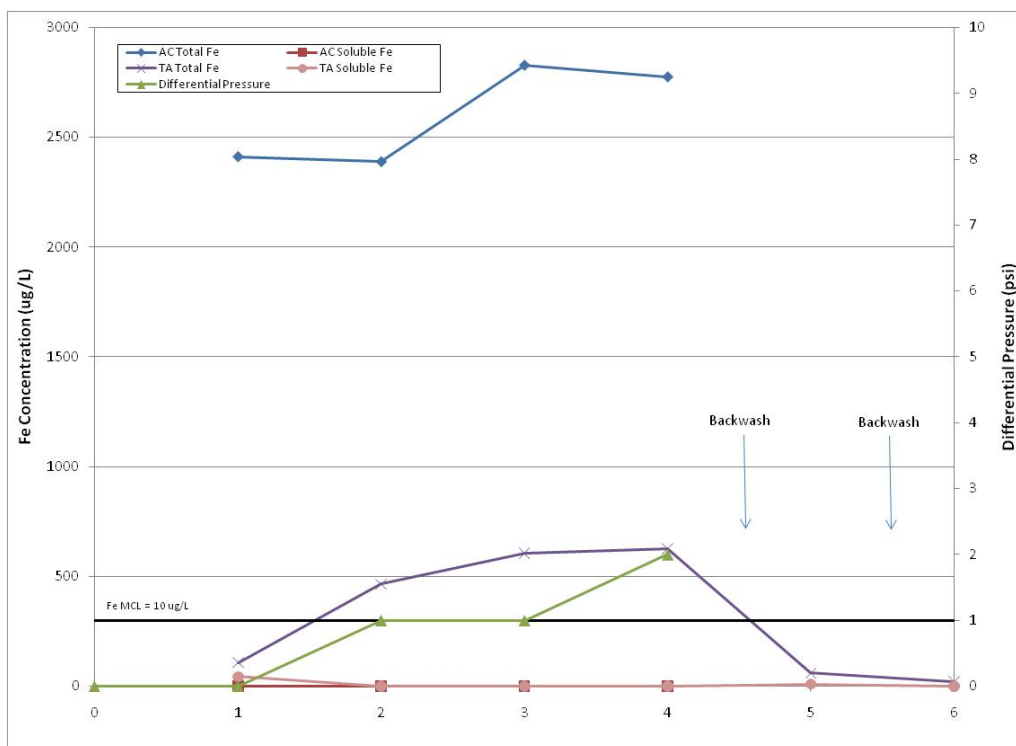


Figure 3. Total and Soluble Iron Concentrations During Initial Run-length Study

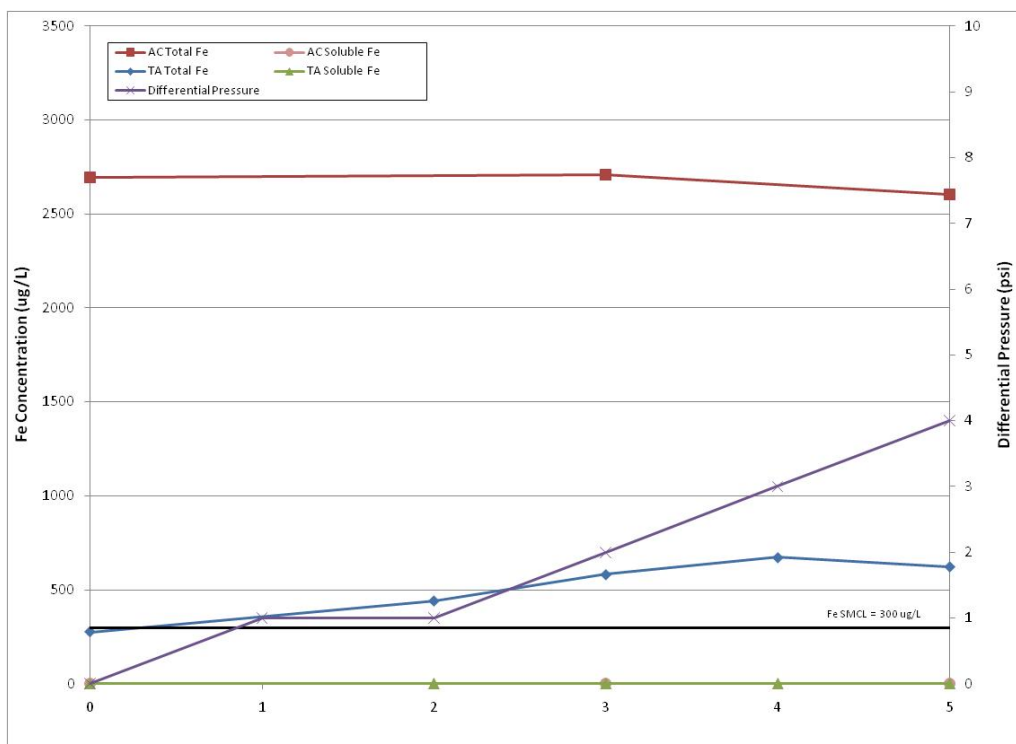


Figure 4. Total and Soluble Iron Concentrations During Resumed Run-length Study

KMnO₄ feed pumps were adjusted during the study so that KMnO₄ residual levels might be maintained at about 0.5 mg/L (as KMnO₄) at the AC location and just above the detection limit at the TA location. As shown in Figure 1, after 2 hr into the study, onsite measurements indicated a total iron concentration of 465 µg/L. Because iron concentrations continued to increase to 625 µg/L at 4 hr, the study was temporarily discontinued to allow Tank A to be backwashed. After two back-to-back backwashes that reduced total iron concentrations to 60 and then 20 µg/L at the beginning of a service run, the study was resumed and allowed to continue for 5 hr.

As shown in Figure 3, similar early iron breakthrough was observed after restart of the run-length study. Particulate iron broke through the filter to values above the SMCL within the first 2 hr. Total arsenic broke through in a similar timeframe (see Figures 2 and 4), however, soluble arsenic concentrations remained relatively stable at 6.6 to 6.7 µg/L. This indicates that the increase in arsenic at the TA location was due solely to particulate arsenic. It is recommended that a contact/slow-mix tank be installed immediately downstream of the chemical injection point and a coagulant aid be added to facilitate formation of arsenic-laden iron particles for better filtration.

Table 5. Analytical Data from Filter Run-length Study

Location	Date @ Time	Conditions	DO (mg/L)	ORP (mV)	KMnO ₄ (mg/L) ^(a)	Total Fe (µg/L)	Soluble Fe (µg/L)	Total Mn (µg/L)	Soluble Mn (µg/L)	Total As (µg/L)	Soluble As (µg/L)	As(III) (µg/L)	As(V) (µg/L)
<i>Baseline</i>													
Well 1	07/27/10 @ 0830	-	0.21	-53.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
Well 1	07/30/10 @ 0930	-	NA	NA	NA	2459	2231	151	152	29.3	31.7	13.7	18.0
Well 2	07/27/10 @ 0845	-	0.20	-71.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
Well 2	07/30/10 @ 0945	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
AC	07/27/10 @ 0900	W/KMnO ₄	0.10	231.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
AC	07/27/10 @ 0915	WO/ KMnO ₄	0.11	-20.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
AC	07/30/10 @ 1015	WO/ KMnO ₄	NA	NA	0.00	NA	NA	NA	NA	NA	NA	NA	NA
<i>Run-length Study</i>													
AC	07/30/10 @ 1015 – 1 hr	W/KMnO ₄	NA	NA	0.20	2412	<25	993	237	32.4	8.8	0.1	8.7
TA	07/30/10 @ 1015 – 1 hr	W/KMnO ₄	NA	NA	0.01	108	43.4	521	521	6.0	6.7	0.8	6.0
AC	07/30/10 @ 1115 – 2 hr	W/KMnO ₄	NA	NA	0.79	2389	<25	988	175	32.0	9.1	NA	NA
TA	07/30/10 @ 1115 – 2 hr	W/KMnO ₄	NA	NA	0.01	465	<25	649	541	9.2	6.1	NA	NA
AC	07/30/10 @ 1215 – 3 hr	W/KMnO ₄	NA	NA	0.76	2829	<25	1016	180	32.1	9.4	NA	NA
TA	07/30/10 @ 1215 – 3 hr	W/KMnO ₄	NA	NA	0.07	605	<25	550	425	11.0	6.1	NA	NA
AC	07/30/10 @ 1315 – 4 hr	W/KMnO ₄	NA	NA	0.49	2776	<25	1013	214	32.4	9.1	NA	NA
TA	07/20/10 @ 1315 – 4 hr	W/KMnO ₄	NA	NA	0.05	625	<25	516	357	11.3	6.2	NA	NA
<i>Tank A Backwashed 7/30/10 @ 1333 and 1426</i>													
TA	07/30/10 @ 1409	W/KMnO ₄	NA	NA	0.00	60 ^(a)	10 ^(a)	NA	NA	NA	NA	NA	NA
TA	07/30/10 @ 1510	W/KMnO ₄	NA	NA	0.41	20 ^(a)	0 ^(a)	NA	NA	NA	NA	NA	NA
<i>Run-length Study</i>													
AC	07/30/10 @ 1541 – 0 hr	W/KMnO ₄	NA	NA	0.67	2694	<25	830	438	31.3	10.6	NA	NA
TA	07/30/10 @ 1541 – 0 hr	W/KMnO ₄	NA	NA	0.02	276	<25	593	518	9.0	7.4	NA	NA
AC	07/30/10 @ 1641 – 1 hr	W/KMnO ₄	NA	NA	0.26	NA	NA	NA	NA	NA	NA	NA	NA
TA	07/30/10 @ 1641 – 1 hr	W/KMnO ₄	NA	NA	0.04	100 ^(a)	10 ^(a)	NA	NA	NA	NA	NA	NA
AC	07/30/10 @ 1741 – 2 hr	W/KMnO ₄	NA	NA	0.80	NA	NA	NA	NA	NA	NA	NA	NA
TA	07/30/10 @ 1741 – 2 hr	W/KMnO ₄	NA	NA	0.17	441	<25	627	484	10.3	6.7	NA	NA
AC	07/30/20 @ 1836 – 3 hr	W/KMnO ₄	NA	NA	0.59	2708	<25	941	258	31.8	9.5	NA	NA
TA	07/30/20 @ 1836 – 3 hr	W/KMnO ₄	NA	NA	0.00	582	<25	541	386	11.7	6.6	NA	NA
AC	07/30/10 @ 1941 – 4 hr	W/KMnO ₄	NA	NA	0.79	NA	NA	NA	NA	NA	NA	NA	NA
TA	07/30/10 @ 1941 – 4 hr	W/KMnO ₄	NA	NA	0.07	673	<25	540	328	12.9	6.6	NA	NA
AC	07/30/10 @ 2036 – 5 hr	W/KMnO ₄	NA	NA	0.50	2603	<25	951	183	31.0	9.1	NA	NA
TA	07/30/10 @ 2036 – 5 hr	W/KMnO ₄	NA	NA	0.11	624	<25	480	294	12.4	6.7	NA	NA

- (a) Measurements taken onsite with portable Hach meter
 (b) Exceedence of arsenic MCL indicated by red
 (c) Exceedence of iron and manganese SMCLs indicated in yellow